the snake as non-poisonous. I find, however, a large poison-gland; and the author's mistake is probably due to the similarity between the maxillary teeth, which is in striking contrast to the abruptly enlarged anterior fangs of ordinary *Hydrophides*.

Although I am unable to find any external characters by which to separate *H. viperina* from its allies, I should have proposed a new generic name were it not that *Disteira*, Lacép., specimens of the type species of which I have unfortunately no means of investigating, may possibly possess a dentition similar to that of *H. viperina*.

VII.—*On the Organic and Inorganic Changes of* Parkeria, *together with Further Observations on the Nature of the Opaque Scarlet Spherules in Foraminifera.* By H. J. Carter, F.R.S.*

[Plate V.]

In the 'Annals' for March and April last (vol. i., 1888) I described in separate communications "Two new Genera allied to *Loftusia*," viz. *Stoliczkiella Theobaldi* and *Millarella cantabrigiensis*, and the "Nature of the Opaque Scarlet Spherules found in the Chambers and Canals of many Fossilized Foraminifera," the former accompanied by a footnote (p. 180) in which allusion is made to other specimens of *Parkeria* in which *Millarella* appeared to be present in the condition of a "foreign nucleus" over which the *Parkeria* had grown; but it now seems to me (after examination of more specimens of the same kind) that this "nucleus" must have been a subsequent instead of a primary formation, from which the *Millarella* might have spread itself throughout the whole of the *Parkeria*, until the structure of the latter had become obliterated—of course in a living or unfossilized state.

The structure of *Millarella* (for the term here must be used in a generic sense) may be stated to present itself under the form of a minutely reticulated rhizopodous mycelium of a brown colour (Pl. V. fig. 9, *a a*), accompanied more or less

* In this communication it should be remembered that I am treating of "Transformations" only, and not of the natural structure of *Parkeria*, which should be learnt from Prof. Nicholson's illustrated description of this fossil in the 'Annals' for January 1888, vol. i. p. 1, pl. iii.

by equally minute, sparsely branched filaments (fig. 9, *b b*), which may have extended itself throughout the *Parkeria*, so as to destroy by transformation the whole of the structure of the latter and replace it by one which is totally different.

That there are globular rhizopodous organisms similar in outward form and equal in size to any *Parkeria* existing at the present day may be learnt from what Mr. H. B. Brady, F.R.S., &c., has stated in the description of his *Syringammina fragillissima*, which was dredged by Mr. J. Murray in the Faroë Channel during the cruise of H.M.S. 'Triton' ('Challenger' Reports, vol. ix. "Text," p. 242), viz.:—

"Two specimens were secured, but owing to the excessively fragile nature of the test both were much broken. The largest fragment is represented in [his woodcut] figs. *a*, *b*, drawn to the natural size. This specimen is about an inch and a half (38 millim.) in diameter, and about eight tenths of an inch (20 millim.) in thickness; but it is probable that the latter dimension may not be much more than half that of the entire organism; indeed, it is evident that the test, when complete, was a rounded mass which, if developed with any degree of symmetry, must have been a sphere about an inch and a half in diameter." The structure revealed by the fractured surfaces is that of a congeries of branching and inosculating tubes radiating from a common centre, "the walls of which are composed of 'fine sand,' among which is a very large number of minute foraminifera."

To return to *Parkeria*. It is impossible to conceive that a foreign nucleus could get into the centre and destroy its structure in a fossilized state; but not so when it is remembered that the *Parkeria* when fresh was probably as penetrable as Mr. Brady's *Syringammina fragillissima*; further, that the embryo of *Millarella* might have previously existed in that of the *Parkeria*, as in Prof. F. E. Schulze's specimen of *Spongelia pallescens* which was infested with an *Oscillaria*, wherein the larva or ciliated ovum of the sponge already contained several minute reproductive bits of the filament of this Alga, of which, in 1878, he kindly sent me a mounted specimen (Zeitschrift f. wiss. Zool. Bd. xxxii. Taf. v. fig. 7).

However, I had better describe a typical instance of this kind of foreign nucleus in a specimen of *Parkeria* first, and then leave the reader to form his own views as to how it got there. Here the nucleus, which is in a specimen of *Parkeria* about one inch and a half in diameter, passes through its centre, so as to reach the circumference of the *Parkeria* at opposite ends (Pl. V. fig. 1, *a*). In form it is a conical solid cylinder, whose greatest thickness, viz. 9-24ths

inch, is just below the centre, so that it is somewhat swollen here, while the upper end is conical and free and the lower one obtuse and fractured, indicative of previous fixation at this point to some submarine body. In composition it consists of a whitish-yellow, minutely granular substance like "chalk" intermixed with small tracts that are pure white, while the whole is charged with foraminiferal detritus in which the tests are not only fragmentary but very minute, and for the most part globular in form, of different sizes, like *Orbulina* and *Globigerina*, together with numerous grains of glauconite (fig. 1, *a*). All around the circumference of this whitish cylindrical nucleus the structure of the *Parkeria* is more or less obscured by the growth outwards of the dark brown mycelium and filamentous structure of *Millarella*, of which the former (which should be viewed by reflected light) requires a high power to be distinguished in detail, while the latter is easily seen with a much lower one, when it appears as a glistening white thread more or less branched—the glistening white appearance arising from the minute crystalline matter of which it is now composed. This thread or filament is about 1-900th of an inch in diameter, tortuous, and more or less branched; but what its state was when fresh I am not prepared to say. Such filaments often form part of a Saprolegnious Alga; but I could see no appearance of fructification about them.

The white chalk-like part represents the oldest and the darker (fig. 1, *c*) stains (like rot to the naked eye) the youngest parts of the *Millarella*. Nevertheless the chalk-like substance also is pervaded by the reticulated mycelium, which imparts to it the "whitish-brown" colour before mentioned, but which can only be seen with a high power, when the presence of the minute fragments of the Foraminifera in it indicates its originally plastic nature.

It must not be inferred that this kind of nucleus always presents the same shape, for I have several specimens of *Parkeria* in which it is present, wherein both in form and size it is quite different. For instance, in one of these (fig. 2, *a*) it is globular, about half an inch in diameter, surrounded by a dark jagged edge, composed of the brown substance or young structure of *Millarella*, which, on account of the light colour of the specimen of *Parkeria* itself, contrasts strongly with it in this respect, so that the definition of the nucleus is very marked, while it is by no means situated in the centre of the *Parkeria*, but, on the contrary, towards the circumference, where it communicates with the exterior by a small contracted neck (fig. 2, *b*)—the centre of the *Parkeria*

(which is about 1½ inch in diameter) being thus not only at some distance from it, but itself presenting no appearance of any kind of nucleus beyond a confused mass of cellular structure (fig. 2, *d*).

In all instances, however, this kind of nucleus is connected at some point with the exterior or circumference of the *Parkeria* (figs. 1, *b*, and 2, *b*), although in many specimens dark, apparently isolated spots of the brown substance like "rot" may show themselves in different parts of it (fig. 1, *c*).

It is therefore possible that when the *Parkeria* was in a *fresh* state and the *Millarella* in a *plastic* one the latter might, after having destroyed part of the substance of the former and thus having made room for itself, have drawn in the foraminiferal detritus of which the white or chalky portion of the nucleus is composed in the fossilized body, if not the originating particles of the glauconite too, seeing that this mineral may commence in the chamber of a foraminiferal test, as I have already explained ('Annals,' *l. c.* p. 181), although the former, at least, could not have got into it afterwards.

The nucleus of *Parkeria*, as Prof. Nicholson has lately stated (*l. c.* p. 9), is probably always some foreign body, such as the "fragment of a shell," and when otherwise it is probably like that of *Millarella* above described (figs. 1 and 2). Again, when it is the "fragment of a shell," this may be that of a multilocular one, viz. Cephalopodous, which is generally the case, or a flat, turbinated one of a small Gasteropod, which seems to be not so frequent, judging from the small collection of *Parkeriæ* in my possession, which does not amount to more than a dozen specimens, although many more than this have passed through my hands; still, even when the nucleus is a "fragment of a shell," it may be remarked that the *Millarella*, although present in other parts of the *Parkeria*, does not emanate from it, but that, on the contrary, the confines of the "shell-fragment" remain so clearly defined that the commencement of the Parkerian structure (that is, its cœnenchyma) may be seen to rest upon it all round, while it is frequently so small that, in this way, the cœnenchymal structure may be traced up to nearly the centre of the specimen. Indeed, although the *Parkeria* seems to have generally sought some foreign body as a nucleus to begin upon, it is only when the nucleus is a *Millarella* that it is in connexion with the *circumference* of the organism. On the other hand, the centre of the *Parkeria* may present no distinguishable nucleus whatever, and the spot of *Millarella* be situated at some distance from it towards the circumference, as in the case mentioned, which strongly supports the infer-

ence that the latter was an intruder either before or after death, that is, while the *Parkeria* was still fresh or unfossilized.

We have now to turn our attention for a few minutes to an *in*organic or mineralogical change which may take place in *Parkeria*; and for this purpose it is necessary to premise its natural state, so far as my specimens will allow.

In the *purest* form, then, that I possess the tubular structure or cœnenchyma (cœnosteum of Nicholson) is so thin and delicate in appearance and the ultimate structure of its walls so minute that all that I can see in them, under a very high power by reflected light, is an amorphous, pulverulent, translucent substance which, it is worthy of remark, closely resembles that of the "shell-fragment" upon which the *Parkeria* had grown; and thus I am led to infer, with Prof. Nicholson (*op. cit.* p. 5), that both originally were of the same nature, that is "calcareous."

On the other hand, in a less pure condition the lamina or wall thus composed may be more or less covered on each side by a layer of crystalline granular calcite, when, of course, the tubular structure having become thickened becomes more evident, and in this way the greater part of the interior of *Parkeria* may present no trace of the original cœnenchyma whatever *except under section*, when the lamina or wall of the tubular structure is brought into view (figs. 5 and 6).

Where this has been the case the external or circumferential part of the fossil has for some distance inwards been transformed into a hard, compact, petrous shell, composed of a dark black-brown (by transmitted light), waxy-looking mineral, in which the remains of the cœnenchyma may be faintly traced together with filaments of the *Millarella* (fig. 3, *a*). In short, the whole looks like fossilized *Millarella-structure*; but however this may be, on the inner side of this petrous portion little holes begin to destroy its continuity, which soon transforms it into the calcitized cœnenchyma above mentioned (fig. 3, *b*, *c*, and figs. 4, 5, 6). In this case the latter, whose interstices are empty, may occupy one third or more of the interior of the *Parkeria*, so that when the external or more compact part of the specimen is cracked off the inner part of the calcitized portion (fig. 3, *c*) falls out, like the kernel of a nut under similar circumstances, when, from the interstices being *empty*, it presents itself under the form of a spherical ball of tubular reticulated thread-structure of a light brown colour, identically representing a cast of the cœnenchyma. It was under this condition that I formerly made the mistake of describing the skeletal structure of *Parkeria* as being com-

posed of "granular calcspar," which has very properly been considered by Prof. Nicholson (*op. cit.* p. 5) to be a "secondary change."

Of this mineral transformation I possess two instances; and here I would digress for a moment to remark that in *one* the cœnenchyma thus altered is richly charged with another kind of, and much larger, crystal than the calcite, of a dark brown colour by reflected, but amber by transmitted light, which is chiefly situated on the surface of the cavities in the calcitized cœnenchyma, where it contrasts strongly with the light brown calcite not only in size and colour, but in its "regular" tetrahedral summit, which for the most part projects into the empty interstices of the cœnenchyma thus transformed (fig. 4, *d d*).

To examine these crystals more particularly a fragment of each specimen of the transformed cœnenchyma like fig. 4 was treated with *nitric acid*, when the whole of the calcite in each was dissolved with strong effervescence, leaving in one instance nothing at all and in the other a great number of the dark brown crystals mentioned, most of which presented beautifully defined tetrahedral summits, and many the corresponding part also, thus forming "regular octahedrons" about 1-450th inch in diameter. These, although numerous, were too small for *me* to subject to the reducing-flame of a blowpipe (for I should have blown them away), otherwise the residue would probably have been attracted by the magnet, and thus, as in the case of glauconite, of which they appeared to me to be but another form, as will presently appear, they would have been proved to have in like manner been composed of iron.

I was led to this view, first by finding crystalline grains of the same colour mixed with those of glauconite side by side in *Millarella*; secondly, because in the so-called "black grains" *now* forming part of the sea-bed between the north of Scotland and the Faroë Islands, to which I have already alluded ('Annals,' *l. c.* p. 181), the transition of the brown colour of some of the casts of the *Globigerinæ* &c. into green glauconite indicates a preliminary stage only to the latter; thirdly, by the presence among the dissolved-out crystals of the calcitized cœnenchyma of the cast of a *Globigerina* composed of the same kind of mineral; and fourthly, because where these crystals have become disintegrated in this transformed cœnenchyma they have left an *iron-rust* stain. My inference therefore is that they are of the same composition as that of glauconite, only of a different colour. Further than this I cannot go, and therefore must leave the question for mineralogists to

decide, merely adding that, as these crystals appear in *one* of the only two instances of this transformation that I possess, it is not improbable that their presence, which is too striking to be overlooked, is not uncommon.

Let us now return to the evidences of the *organic* changes in the tubular structure or cœnenchyma of *Parkeria* caused by the presence of *Millarella*, and having described the most striking parts of the latter, viz. the brown mycelium and the white filament, it is only necessary for me to add that in one of the specimens in my collection (which unfortunately is only a thick slice between the centre and the circumference of the *Parkeria*) where this transformation is most evident, spots of it may be seen like dark "rot" throughout this slice, intermixed with the white cœnenchyma in its natural state, which presents every gradation, from the dull white *continuous* structure to that which is broken up and finally lost amidst the brown mycelium and glistening mineralized filaments of the *Millarella*. Indeed in some parts the filament appears to have crept along the side of the "*lamina*" forming the wall of the tubulation, while in others the "lamina" itself appears to be yielding to its influence so as itself to become a "glistening" white filament. At all events, the destructive character of the *Millarella* is evidenced by the gradual disappearance of the cœnenchymal structure and the presence of that of *Millarella* (fig. 10, *a*, *h*).

However, I have got another specimen wherein the transformation has extended a little further and the *whole* of the central part of the *Parkeria* has passed into *Millarella*, while the external part has become hard and petrous, like that observed in the "calcite" transformation of the cœnenchyma. This specimen, which was about $1\frac{1}{4}$ inch in diameter, has been cut into halves, of which the petrous portion forms a kind of shell about 3-12ths inch thick, while the rest consists of a solid spherical mass of *Millarella* 9-12ths inch in diameter, but of which unfortunately I have only a tangential section (fig. 7) whose greatest thickness is 3-12ths inch; therefore it is only the *outside* third of the spherical mass that I possess, which is amply sufficient for structural description, although I would rather have had the whole or a section through the centre, that I might also have seen the latter.

Of the external or petrous portion I need only state that in composition and colour it is precisely like that which surrounds the "calcitic" or inorganic transformation above described, while the spherical mass presents through the tangential section all that is to be found in the "nucleus of *Millarella*" first described—that is, the brown mycelium

(fig. 9, *a a*), the filaments (fig. 9, *b b*), and the chalky substance charged with foraminiferal detritus and grains of glauconite (fig. 9, *c*), only arranged in a peculiar manner; thus the internal or plane surface of the tangential section (fig. 7) presents a massive veno-reticulated structure of a light brown colour (fig. 8 *a*), with an equal amount of interstices which are filled with the chalky substance just mentioned (fig. 8, *b*), thus indicating that the whole sphere was composed of this reticulated structure &c.; while in some parts the chalky substance under a high power by reflected light may be seen to be pervaded by the myceliated structure also, in the interstices of which, as well as in its substance generally, the smallest as well as the largest particles of the foraminiferal detritus and grains of glauconite are imbedded. On the other hand, the massive veno-reticulated structure appears to have been chiefly composed of the filamentous part of the *Millarella* (fig. 9, *b b*), which, where the filaments are situated horizontally, are easily recognized, that is *laterally*, although this of course is not the case where the section has passed through them transversely, so that they are more or less represented "end on" (fig. 9, *a a*). In this way the central portion of the *Parkeria* has become a solid mass, in which I could discover no traces of its cœnenchyma. Thus, although analogous in general form to the "calcitic" transformation, it is in other respects perfectly different, inasmuch as the "calcitic" one indicates a mineral or *in*organic change, while the imbedded fragments of foreign matter in the *Millarella* are a decided evidence of an organic one.

Of the nature of *Millarella* when fresh I can only repeat what has been before stated, viz. that it appears to have belonged to some Saprolegnious Alga both in its plastic character and destructive agency—the former indicated by the imbedding in its mycelium of *foreign* material whose animal forms are perfectly evident, and the latter evidenced by the entire transformation of the cœnenchyma of the *Parkeria* into *Millarella*; while the latter in its independent existence has been described under the name of "*Millarella cantabrigiensis*" in this periodical (*l. c.* p. 178)*.

Further Observations on the "Opaque Scarlet Spherules."

When I was engaged in describing the "opaque scarlet spherules" which are confined to the chambers and canals of

* It now seems to me that the forms of *Loftusia persica* and *Stoliczkiella Theobaldi* are so unlike any that would be produced by *Millarella* alone that it is not impossible that these organisms respectively might, like *Parkeria*, have become invaded by a *Millarella*.

certain fossilized Foraminifera (*op. et l. c.*) I had not observed that similar spherules were equally abundant in the interstices of the cœnenchyma of *Parkeria*, and that they evidently passed from the "scarlet" state into that of "pyrites;" while the apparently "granular" composition which they presented both here and in the Foraminifera could not be ascribed to any previous organic, but to some subsequent mineralogic structure, wherein the granular appearance on the surface had in all probability been produced by the facets of the ends of the radiating pillar-structure of which spherical pyrites is composed.

Still, although the "opaque scarlet spherule" may be of general occurrence and merely a mineralogical form of iron (for I think I have seen such in trap-agates which certainly cannot possess any fossilized *organic* structure), yet the fact of these bodies in fossilized Foraminifera being *confined* to the "chambers and canals"—as a colourless or white fossilization of another species of Foraminifera, viz. *Orbitolites* (*Orbitoides*, D'Orbigny) *Mantelli*, Carter, just ground down for the purpose, has still further confirmed—indicates that there must be a connexion between the "scarlet spherules" and something in the sarcodiferous cavities which led to their formation. Then certainly follows the question, What was the form of that "something," and did it lead to the spherical form of the "scarlet spherule," or is this only a natural consequence of the increase in size of a particle of iron destined in its growth to assume this form?

Such reflections are engendered by further research into the nature of the "scarlet spherules," for, however great the connexion may appear to be between certain contents of the sarcode in the chambers of living Foraminifera—which in this state is generally charged with spherical cells of a similar form that have been *proved* by M. Schultze ('Annals,' *l. c.* p. 177) to be *reproductive bodies*—and these "scarlet spherules" in a fossilized one, it is impossible in the present state of our knowledge to disregard the fact without being influenced by its contingencies in the opinion that should be formed of the nature of these "spherules."

Of course "brown hæmatite," of which, under another colour, these spherules are composed, is extremely common in all kinds of fossils; but the question here is, Why should it be *confined* in the Foraminifera to their sarcodal cavities, and there look so much like the "reproductive bodies" which are found in the same position in the living animal?

EXPLANATION OF PLATE V.

N.B.—All the illustrations are more or less diagrammatic, as it would be impossible in the small space of an octavo page to give them otherwise; hence this must be left for a future occasion, when it may be thought desirable to draw the representations to scale in which all their parts would be relatively magnified.

Fig. 1. *Millarella* in the form of a cylindrical nucleus passing through the centre of a *Parkeria*. Section through the centre, nat. size. *a*, chalk-like portion charged with foraminiferal detritus and grains of glauconite, the latter represented by the dark puncta; *b*, point of communication with the exterior; *c*, dark shades intended to represent spots of *Millarella* scattered throughout the fossil; *d*, radiated structure of the *Parkeria*.

Fig. 2. The same, but with the *Millarella* of a globular form, confined to the circumference of the *Parkeria*, and thus separated from the centre, which, in this instance, does not appear to possess any nucleus whatever. *a*, *Millarella*; *b*, its communication with the exterior; *c*, radiate structure of the *Parkeria*; *d*, centre of the same.

Fig. 3. *Parkeria* in which the central portion of the cœnenchyma has become calcitized. Section through the centre, magnified two diameters. *a*, external or petrous portion; *b* and *c*, transformation of the same into calcitized tissue; *d*, imaginary line of separation between *b* and *c*, to point out the part where the division between *b* and *c* is supposed to take place when, on the cracking off of the petrous portion, *c* falls out in a spherical form.

Fig. 4. The same. Fragment of the calcitized cœnenchyma much magnified, to show *a a a*, the "concentric lamellæ," *b b*, the "radiating columns," *c c*, the intervals between them, *d d*, the "tetrahedral" crystals of supposed silicate of iron.

Fig. 5. The same. Two portions of the tubulation of the calcitized cœnenchyma cut across to show their structure, greatly magnified. *a*, cavity of the tubule; *b*, wall of the same entire; *c*, external layer of the granular calcite; *d*, internal layer; *e e e*, the same, showing the remains *only* of the tubular wall; *f*, calcitized tubule, in which there are no remains of the "wall" whatever.

Fig. 6. The same. Lateral view of a fragment of a tubule, magnified upon the same scale. *a*, wall of the tubule; *b*, its cavity; *c*, external layer of granular calcite; *d*, internal layer of the same.

Fig. 7. Tangential section of the central portion of a *Parkeria wholly* transformed into *Millarella*, viewed from the interior or the plane side. Nat. size.

Fig. 8. The same. Fragment of the surface greatly magnified, to show its reticulated structure and chalky intervals. *a*, veno-reticulation, indicated by the darker shade; *b*, chalk-like material in which the grains of glauconite are indicated by the dark puncta.

Fig. 9. Fragment of the latter very much more magnified, to show the composition of the two structures, viz.:—*a a*, structure of the veno-reticulation in the tangential section where seen "end on;" *b b*, filamentous parts where seen laterally; *c*, chalky intervals charged with foraminiferal detritus and grains of glauconite.

Fig. 10. Diagram to show the replacement of the cœnenchymal structure of *Parkeria* by *Millarella*. *a*, cœnenchyma *continuous*; *b*, "zooidal tube;" *c*, cœnenchymal structure breaking up and disappearing; *d*, dark shade in the tubules of the cœnenchymal structure, indicating the presence of *Millarella* in its minute form, of a brown colour; *e*, filamentous form; *f*, chalk-like portion; *g*, fragments of foraminiferal detritus; *h*, grains of glauconite.

Budleigh Salterton, Devon,
June 1, 1888.

VIII.—*Descriptions of new Land-Shells from the Andaman and Nicobar group of Islands in the Bay of Bengal.* By Lieut.-Col. H. H. Godwin-Austen, F.R.S., F.Z.S., &c.

My old conchological colleague and friend Geoffrey Nevill a few months before his early death sent me his revised and interleaved copy of the Catalogue or Hand-list of the Mollusca in the Indian Museum, Calcutta, of which it was intended to be the second edition; and this I hope the trustees of that museum will sooner or later have put into type. It contains a mass of new material, references to original descriptions, and a large number of species added to the museum since 1878, and a great number of MS. names given to undescribed forms. Of many of these new Indian species he had sent me typical shells, some of which I have figured and described in 'Land and Freshwater Mollusca of India,' and many I still have by me. From Mr. F. A. de Roepstorff I had received many Andamanese and Nicobar shells, and after that officer's melancholy death by the hands of a sepoy at Camorta, Mrs. de Roepstorff very kindly sent me his large collection of land-shells. With this material I am able to complete the good work begun by Geoffrey Nevill and identify the shells bearing his MS. names and describe the same. MS. names, unless thus quickly dealt with, become a terrible source of vexation and worry to future naturalists; they wander away into collections all over the world, are very frequently never published, while some species rejoice in two or more such titles. I therefore in this paper propose to clear off as many undescribed shells as I can from the islands of the Bay of Bengal, trusting to be able to figure them in the second volume of my work on Indian Mollusca, and in some cases give some further account of those I have in spirit.